Judge Berman
Daniel Patrick Moynihan
United States Courthouse
500 Pearl St.
New York, NY 10007-1312

MEMO ENDORSED
See Attached Order
Clerk to Docket

August 31, 2015

Dear Honorable Judge Berman,

I have been following the controversy regarding "deflategate" and the court case. Being frustrated with the lack of substantive discussion regarding the science behind football inflation, I recently conducted some experiments on the weekend. I am not affliated with any party in this matter. Moreover, while I am a professional scientist (environmental chemist at the Woods Hole Oceanographic Institution), I will ready attest that these experiments were low-budget and conducted on a limited time frame (my personal hours). Nevertheless, the results imply that **it is impossible for teams to be in compliance with the 1 PSI pressure range regulations without accounting for changes in environmental conditions**, and that as currently enforced (subjecting unequilibrated footballs to indoors halftime spot checks) **will result in all footballs being in violation once winter conditions arrive.**

Based on these observations, and the reading of the Wells report, it is my opinion that the league's lack of attention to consistent ball inflation inspection and enforcement pressure conditions (including environmental conditions) could explain the context of internal Patriots discussions (e.g. concern about footballs inflated by referrees to 16 PSI) as satisfactorily as the implied wrongdoing.

These results have been posted to a blog bluemassgroup.com, although I have not been able to interest the media in these observations. I have considered working up these results for a peer-reviewed scientific publication, but frankly, I should probably spend my limited energies on our studies of the oceans and our human society's influence on them.

Thank you for your efforts in this and other cases.

Sincerely,

Mak Saito
Associate Scientist with Tenure
Marine Chemistry and Geochemistry Department
Woods Hole Oceanographic Institution
Woods Hole MA 02543
www.whoi.edu/saitolab

Northern NFL Teams Will Need Many Backup Quarterbacks

mak | Wed, Aug 5, 2015 2:56 PM EST | Edit Post

What if the smoking gun isn't? - promoted by charley-on-the-mta

The other day I was reading a news story about deflategate that had the football pressure data in it from the AFC Championship game. Being a scientist, I gave into the temptation to plot it up, which then led to the desire for a little more data. So off my sons and I went to the sporting good store over the weekend where we purchased a football and a gauge. We took the football out of the box, and ... put it in the fridge. Here's what we found.

In all five experiments putting the football from room temperature (75-78 degrees F) to the refrigerator (34-37 degress F) resulted in a pressure drop of more than 2 pounds per square inch (PSI; Figure 1 for graph of data, simple version). Upon being removed from the fridge, the PSI increased rapidly within the first 10-15 minutes. In two cases the pressure did not return to the original pressure (by 1.1 and 0.5 PSI), while in three cases it roughly did. We did not try to replicate the conditions of the AFC game because, frankly, it was the weekend and the fridge is what I had access to at home.

Three major conclusions are clear from these experiments. First, if these experiments are generalizable to winter football with comparable temperatures, in other words all games in near freezing conditions with outdoor stadiums, all footballs will be in violation of the current NFL rules and their current enforcement approach at some point during the game. Specifically, footballs filled and tested indoors that are brought outdoors will drop in excess of 2 PSI, which is two-fold larger than the 1 PSI allowed range (12.5-13.5 PSI). If they are tested while still cold, or immediately after being brought in, they will be in violation. This is regardless of if the footballs are filled to 13.5 or 12.5, each pressure subtracting 2 PSI will be in violation. These experiments did use a Wilson Official Composite football instead of the Wilson Professional Leather one, so the results may vary (as they would also with other varying environmental parameters) but similar effects would be expected.

If ball pressure is inspected and enforced as it was during the AFC Championship games, as would be expected given the high profile nature of the disciplinary actions and the need to protect the "integrity" of the game, NFL teams are going to need a lot of backup quarterbacks to replace the quarterbacks lost each game. Visiting teams from warmer climates would be wise to play their backups quarterbacks as a sacrifice to maintain them for future games, rather than lose them for four games. Teams from colder climates will need to dedicate more of their roster space for backup quarterbacks or risk running out of them by the end of the season.

Second, the Wells report argued that the large variability in football pressure in Patriots balls was indicative of tampering while the close spread of pressure values in the Colts balls could be used as a control group (see Figure 2, simple version) Our data demonstrates this same observations can also be explained by when the timing of sampling occurs. For example, when footballs are brought from a cold outdoor temperature to a warm indoor one, as occurred in the AFC championship game, there is a period of rapid re-equilibration where measured pressure correspondingly increases rapidly, followed by a plateauing where pressure converge. The time scales and our simple experimental data are consistent with this, where pressures measured in the first 15 minutes had a PSI range of 1.5, while those measured between 16-30 minutes had a PSI range of 0.5. During halftime the Patriots balls were measured first, then 5 Colts balls were measured and halftime came to an end. Interestingly, none of the Colts balls reached their initial estimated (and not recorded value) of about 13 PSI, suggesting a loss or incomplete re-equilibration, consistent with loss of pressure observed in two of our five experiments.

Third, there's a systematic error between the two referees' pressure gauges of 0.39 +/- 0.06. This has been much discussed in the media and Wells report. What has not been discussed is the notion of accuracy (and in contrast to precision). In analytical chemistry accuracy is a term used to describe the confidence associated with a measurement based on how close that measurement is to the true value. To acquire accuracy, chemists typically measure certified or consensus standards that are widely shared among laboratories. The process is simple, you measure the shared standard, if your number is far from the certified number, you've got a problem with your accuracy. The referees chose to use two different gauges during the halftime of the AFC game given the scrutiny they expected. This was a good idea as it gives us some real life information about the performance of gauges in use by referees. Turns out that a 0.39 PSI variability is ~40% of the allowed 1 PSI range - a football that is within the allowed range by 0.3 PSI could be found in violation by an inaccurate gauge. The NFL decided to use the data from only one gauges, assuming the other was inaccurate. But this is not valid, we don't know which gauge (if any) was more accurate because there were no standards used to verify their calibration at the time of their use. If footballs need to be above 12.5 by both gauges, which seems reasonable since we do not know one to be more correct than the other, all of the Colts footballs except one are also in violation (Figure 2, the grey area indicates allowed pressures). The gauges are calibrated in the factory, and the referees are optimistically assuming those calibrations will be maintained and not drift with wear and tear. In light of this large uncertainty in referee gauge accuracy and to avoid any possibility of being in violation, teams should fill their balls to exactly within the middle of the 1 PSI range (13.0 PSI), since 13.2 or 12.7 could be found in violation by an inaccurate gauge.

I know an immediate comment will be why didn't we try to recreate the conditions of the AFC championship game with the smaller temperature change (reported to be ~50 degrees F outside). The short answer, as mentioned above, is that this isn't my day job, just some simple experiments done at home on the weekend, not in my chemistry lab at work. Others have done experiments under conditions mimicking the game in question, and found similar results (~0.9 PSI decreases). But that said the scientist in me couldn't take reading any more vague news articles about this, and I was wondering what was really happening in those footballs. Since we did not recreate the specific game conditions, I have made the conclusions generalizable to the challenges facing teams trying to comply with the pressure rules next season. But obviously I'm being somewhat flip: without taking into account changes in temperature on ball pressure (e.g. when and at what temperature the game balls will be re-examined) and having at least *some* policy for verifying accuracy of pressure gauges, the existing rules are basically impossible to lawfully adhere to.

There have been numerous physicists getting quoted on whether the Ideal Gas Law could explain the pressure changes. It seems fair to conclude that having lawyers asking physicists to make calculations about vessels made of pig, which are repeatedly crushed by very large human masses, used in highly variable physical environments, and measured with uncalibrated gauges is quite far from "ideal". Here, a few actual measurements with inexpensive supplies goes a long way to understanding football pressure in real world conditions.

Note the red line that simulates "halftime" inspect. and the rapid increase in pressure. Balls checked later will appear closer to their original pressure

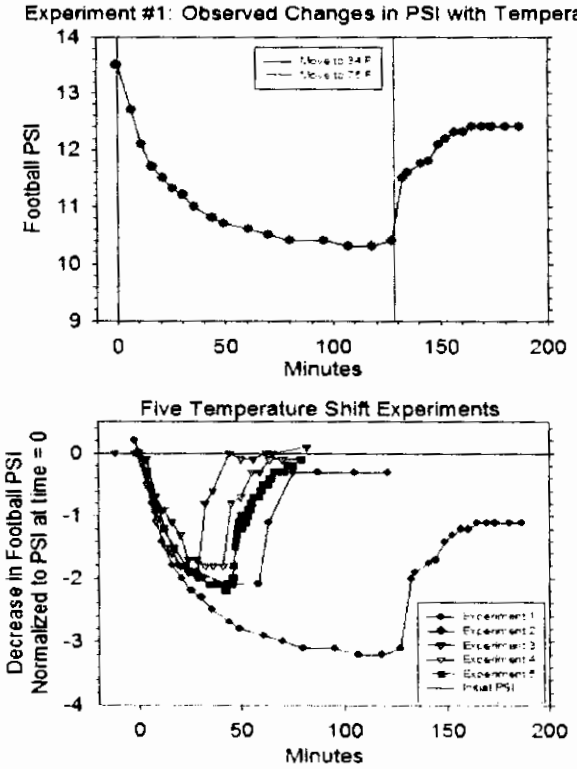

Figure 1. In five experiments ball pressure decreased >2 PSI when moved from ambient room temperature (75-79°F) to a refrigerator (34-37°F). Top) Experiment #1 began at 13.5 PSI at room temperature, losing almost 3 PSI over two hours, and rapidly recovered to 12.5 PSI when moved to room temperature. Bottom) All five experiments are plotted with the transition to 34-37°F occurring at zero minutes and with initial ball pressures of 13.5, 13.5, 13.2, 12.5 and 12.5, respectively. The lower temperature (34-37°F) used reflects available equipment (home refrigerator) and simulates outdoor winter conditions rather than trying to recreate a specific game scenario. Under these typical winter conditions, all footballs inflated within the correct pressure range at room temperature (12.5-13.5 PSI) would fail re-inspection by dropping below the allowed pressure range if the balls are measured prior to temperature re-equilibration. In some instances (experiments 1 and 2) the balls failed to return to the initial PSI for reasons unknown, similar to the Colts balls which did not return to their original ~13 PSI (see Figure 2).

The spread of datapoints in Patriots balls can be reproduced by re-equilibration indoors.

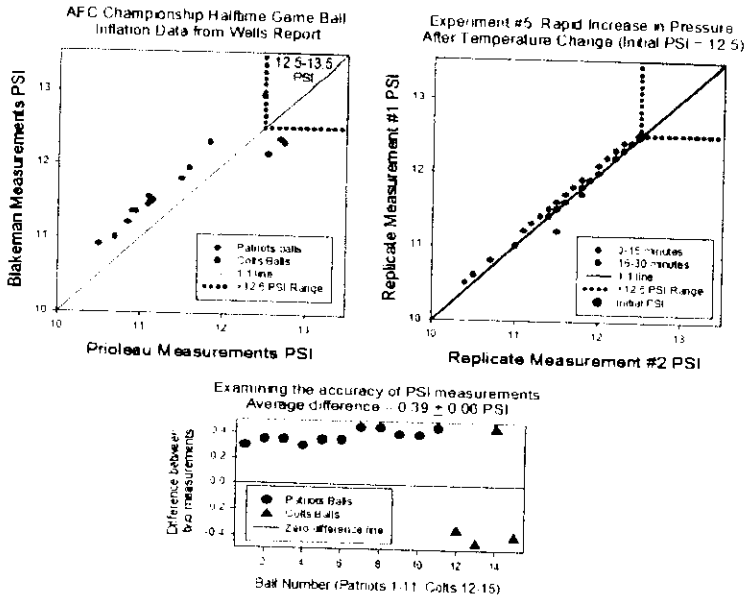

Figure 2. Left: data reported by Wells et al.(2015) showing two replicate measurements by referees Blakeman and Prioleau. Offsets from the diagonal 1:1 line indicates systematic error of 0.39 with a standard deviation of 0.06 caused by variability in the uncalibrated gauges. All but one of the 15 balls re-measured at halftime were found gauges to not be in the 12.5-13.5 PSI range of both gauges (grey region). The large range in Patriots PSI data was speculated to be evidence of tampering (Wells et al 2015).Yet this variability is easily reproduced (Top Right Panel) using replicate measurements from Experiment 5 (see Figure 1) every 30-60 seconds during the rapid re-equilibration with room temperature. During the first 15 minutes rapid increases in PSI caused by the temperature shift were observed similar to the blue data points in the left panel, whereas by the last 15 minutes the ball were further equilibrated and resulted in a smaller pressure range. Bottom: Difference between the two referees' gauges reveals a systematic offset of 0.39 +/- 0.06. Without calibration using reference materials at the time of use, the accuracy of neither gauge can be reliably determined.

Published online at:

http://bluemassgroup.com/2015/08/northern-nfl-teams-will-need-many-backup-quarterbacks/

ORDER

Thank you for your submission – I apologize for the delay in responding.

We have placed your submission on the court dockets for the NFL v. NFLPA (Tom Brady) matter (15 Civ. 5916 and 15 Civ. 5982).

RMB

Richard M. Berman, USDJ

9/9/15